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THE IMPACT OF VARIOUS COMPRESSION RATIO AND INFLUENCE OF BIO ADDITIVE WITH JATROPHA METHYL ESTER BIODIESEL IN DI DIESEL ENGINE

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ABSTRACT

The rapid depletion of petroleum fuels and their ever increasing costs have led to an intensive search for alternative fuels. Also, there was a need to reduce the consumption of diesel fuel in the developed and in the developing countries. The increasing industrialization and innovation of the world lead to a steep rise in the consumption and demand of the petroleum based fuels every year. The experimental work to evaluate the impact of various compression ratio using blends of diesel fuel with 20% concentration of Methyl Ester of Jatropha biodiesel blended with bio additive as an alternate fuel. The experiment was carried out with three different compression ratio in DI diesel engine. Biodiesel was extracted from Jatropha oil, 20% (B20) concentration with 3 ml bio additive is found to be the best blend ratio from the earlier experimental study. The biodiesel B20MEOJBA3 ml is tested with various compression ratio of 17.5, 16.5 and 15.5 respectively. The main objective is to obtain better efficiency, minimum specific fuel consumption and lesser emission using 3ml bio additive blends with biodiesel when compared with baseline diesel.

KEYWORDS: Methyl Ester of Jatropha, Bio Additive, Various Compression Ratio, Performance & Emission

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Original Article

INTRODUCTION

The primary source for social growth and economic development is mainly depending on energy. The role of energy has got a direct impact on the growth of industries which contributes for the development of country's economy[1]. In many countries, the diesel engines are widely used as prime movers in the field of power generation, agriculture and transportation[2]. The world at presentencounter with the twin crisis depletion of fossil fuel and degradation of environment which has put a restriction in the usage of conventional fuels. During the last few decades the alternate fuel search has been intensified due to depletion of fossil fuel[3].

Bio-fuels are produced from living organisms or from metabolic by-products (organic or food waste products). Bio-fuel contains 80 percent of renewable materials which was actually derived from the photosynthesis process and can be referred to solar energy sources. The consumption of bio-fuel as supply of fuel is as aged as the diesel engine. Rudolph Diesel, who had invented the diesel engine, has conducted various experiments to identify the renewable energy from a wide range of fuels which take account of numerous Biofuels. At the World's Fair in 1900, Rudolph Diesel is honored with Grand Prix, the Fair's highest honor for demonstrating the effectiveness of high competence diesel engine employing peanut oil. In 1912, Diesel predicted and expressed, "the application of biofuel as alternative fuels for engines which seems to be insignificant today, but alternate fuel will dominate in the future years. He also added that in the future, alternate fuels will be as vital as the petroleum, coal and tar products of our time". In spite of

Rudolph's confidence, the utilization of biodiesel as a feasible petroleum choice has frequently been inspected.

The global biodiesel production is from consumable oils, for example, soyabean, rice bran oil and mustarded oils. While, India is not independent in eatable oil making, subsequently beating of non-consumable oil is fast approaching for biodiesel generation[4]. With plenitude of land and plant based non-consumable oil being accessible in our nation, for example, karanja, jatropha, mahua, sal, neem and rubber are only few investigations was done to employ esters of these non-edible oils as replacement for diesel[5].

In India, the remote rural and forest communities using Jatropha oil (i.e. without refining) as biodiesel in diesel engine and generators for several decades. The earlier experimentation with methyl ester of Jatropha has been carried out for finding the best blend (B20) and 3ml bio additive[6,7]. The objective of this study is to investigate about the usage of biodiesel and bio additive blended in order to minimize the emissions of all regulated pollutants from diesel engine. The experiment is further analyzed with the influence of various compression ratios on engine for bio fuels.

EFFECT OF ADDITIVES AND COMPRESSION RATIO IN DIESEL ENGINE

The experiments are carried out under various characteristics in twofold biodiesel of Thumba biodiesel on a mono cylinder VCR diesel engine that has bore diameter 87.50 mm, imperial power 3.5 kw at 1500 rpm, firmness ratios 12 to 18, stroke length 110mm, water cooled engine. Biodiesel unifies B10% (combination of Diesel 90% by quantity, biodiesel 10% by volume) and B20% (mishmash of Diesel 80% by quantity, biodiesel 20% by quantity) gave better BTE and lower BSFC than other biodiesel blends. The blends of B10% and B20% have lower emission than other blends which are similar to diesel. Investigation reports show that unified thumba oil is noticed to be a capable and suitable fuel for firmness and detonation of engines. At CR 18 BTE and BSFC of Thumba B10, B20 and BP of Thumba B40 confirmed better recital. CO, HC, CO_2 of B100 of Thumba biodiesel which showed less emission percentage/ppm, for NOx emission B10 and B20 of Thumba, biodiesel showed less emission of ppm[8].

This study examined the effects of different blends of Annona Methyl Ester in VCR engine. The performance, emission and combustion parameter were measured in all compression ratios. The compression ratio was varied in 16.5, 18.5 and 19.5. The experimental analyses were conducted in various combinations of additive blends with compression ratio. The Annona Methyl Ester of 20% showed better in performance and combustion. Overall performance was high in compression ratio with lower blends devoid of any alteration of the engine[9].

The test was conducted in uneven firmness ratio engine (VCR) with methyl ester of jatropha oil (MEOJ) and diesel. The analysis was conducted with 14, 16, 18 and 20 compression ratio with Jatropha blends. The performance parameter BTE and BSFC were measuredin VCR engine. The emission parameter such as CO, CO_2, HC, NO_x and smoke density was also noted. It was noticed that higher CR, performance of engine increased apparently with less BSFC for biodiesel blends fuel. The emission was higher for CO and CO_2, but for HC, NOx and smoke density wasreducedfor higher CR. The higher compression ratio of the combustion parameters is improved with the blends of biodiesel [10].

In the present work the bio mileage is used as an additive with 20% of Methyl Ester of Jatropha. The additive 3ml is blended with B20MEOJ in order to increase the cetane number in biodiesel. This additive will gives better performance with biodiesel and less emission at different loads.

EXPERIMENTAL SETUP

This experimental work carried out in three different compression ratio and varying loads at constant speed of 1500 rpm, four stroke, single cylinder, vertical, water cooled DI diesel engine. The specifications of engine are table 1. Both diesel and biodiesel fuel are injected at 23ºBTDC. Biodiesel was extracted from Jatropha oil used in 20% (B20) concentration with diesel. The bio additive of 3 ml is added with B20MEOM and the experiment is conducted to varythe 17.5, 16.5 and 15.5 compression ratios. And also a physical property of 3ml bioadditive with Methyl Ester of Jatropha is given in table 2. Smoke density reading is identified by smoke meter in HSU. The emissions like hydrocarbon, carbon monoxide and oxides of nitrogen is measured using digas analyser from engine tail pipe. Engine load was applied by adjusting knob, which in turn connected to eddy current dynamometer.

Table 1: Details of Experimental Engine

Manufacturer	Kirlosker TV – I
Category	Vertical cylinder, DI diesel engine, VCR engine
Number of cylinder	1
Bore X Stroke	87.5 mm X 110 mm
Compression ratio	17.5
Speed	1500 rpm
Rated brake power	5.2 kW
Cooling system	Water cooling
Injection timing	23°BDTC

The test is done to analyse the impact of various compression ratio and influence of bio additive with jatropha methyl ester biodiesel in DI diesel. The line diagram of the experimental setup is shown in figure 1. The performance parameter BTE and SFC were measured in VCR engine. The emission parameter such as CO, CO_2, HC, NO_x and smoke density is measured. The combustion parameter like cylinder pressure and heat release rate is measured by using AVL combustion analyzer.

Table 2: Physical Properties in 3mlBFA

Test Property	3ml BFA
Density at 15° C kg/m^3	827.1
Kinematic Viscosity at 40°C	2.53
Flash Point (PMCC) °C, (min)	48
Cetane number	60
Gross Colorific value k.cal/kg	41670.4

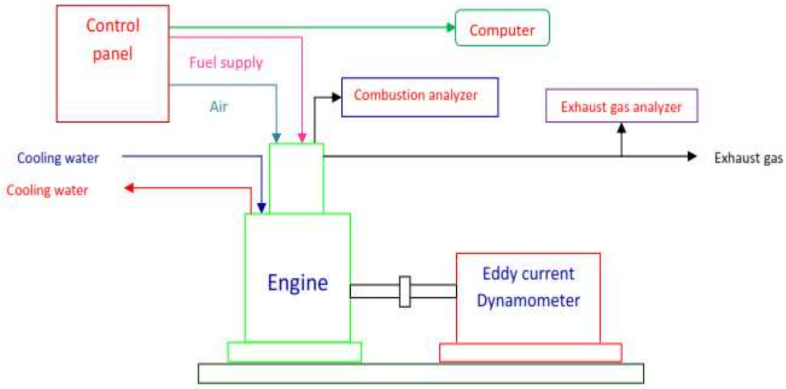

Figure 1: Line Sketch of Experimental Setup

RESULTS AND DISCUSSIONS

Performance Characteristics

The deviation of specific fuel consumption with different load for diesel and B20MEOJBA3ml is depicted in figure 2. The SFC with compression ratio of 17.5 at maximum load condition is measured 0.3 kg/kW-hr and 0.3 kg/kW-hr for diesel and B20MEOJBA3ml respectively. At maximum load the compression ratio of 16.5 and 15.5, the SFC is 0.32 and 0.35 kg/kW-hr for diesel and B20MEOJBA3ml respectively. Also SFC is 0.36, and 0.37 kg/kW-hr for B20MEOJBA3ml. For lower compression ratio of 16.5 and 15.5, SFC increases for both diesel and B20MEOJBA3ml. This is due to lower pressure inside the combustion chamber [11].

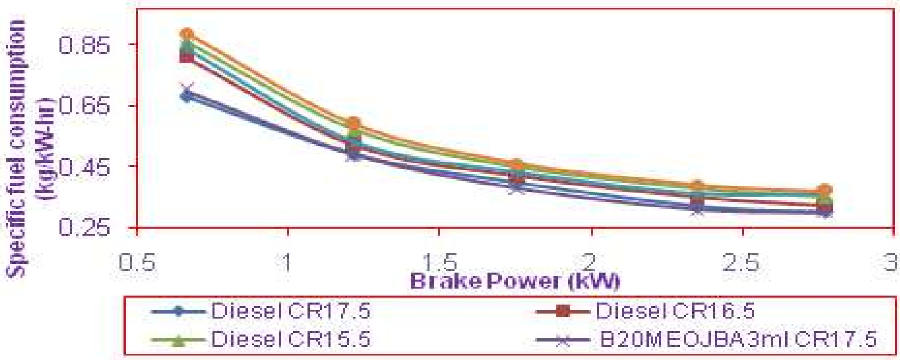

Figure 2: Specific Fuel Consumption with Brake Power(B20MEOJBA-CR)

The change in BTE with regard to brake power is plotted in figure 3. The value of BTE with compression ratio of 17.5 similar trends is noted in both diesel and B20MEOJBA3ml. At maximum load, BTE of 28.18% is found in diesel under the compression ratio 17.5 whereas it was 28.12% using B20MEOJBA3ml compression ratio 17.5. BTE value of B20MEOJBA3ml is measured at partial load condition closer to diesel. In full load compression ratio 16.5, BTE is decreased by 1.2% in the diesel and B20MEOJBA3ml. Poor mixture formed due to prime dilution achieved in combustion chamber resulted in decrease of efficiency[12].

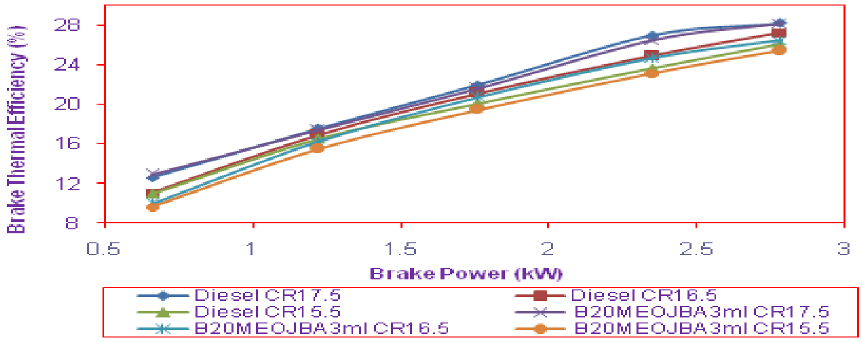

Figure 3: Brake Thermal Efficiency with Brake Power (B20MEOJBA-CR)

Emission Characteristics

The comparison between smoke density and brake power is shown in figure 4. Smoke density is observed to be lesser for B20MEOJBA3ml blend when compared to diesel for various combinations of load and CR. The occurrence of O_2 in B20MEOJBA3ml blend configuration can significantly contribute to the lessening in smoke emission for varying loads. If the compression ratio decreases, smoke density is raised. In maximum load, the amount of smoke value of diesel is 81.2 HSU and B20MEOJBA3ml blend is 57.1 HSU at compression ratio 17.5. Lower compression ratio drops the accessibility of O_2 for burning of fuel it reasonably reports in partial burning and improved development of particulate matter [13].

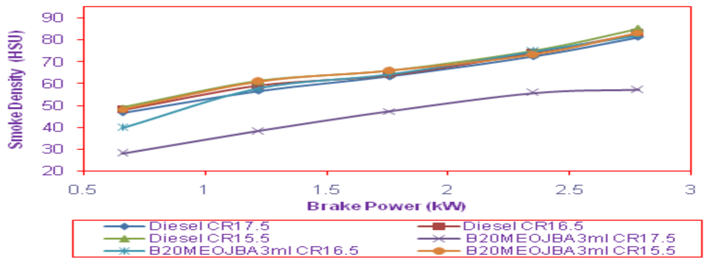

Figure 4: Smoke Density with Brake Power (B20MEOJBA-CR)

The change in comparing the nitrogen oxide with brake power is exhibited in figure 5. Nitrogen oxide is noted in diesel 1572 ppm and 1779 ppm for B20MEOJBA3ml in higher compression ratio at complete load. With decrease in compression ratio, Nitrogen oxide is also lessened. With the compression ratio of 15.5, Nitrogen oxide ranges are 846 ppm for diesel and 905 ppm for B20MEOJBA3ml. For both diesel and B20MEOJBA3ml blend NOx level was increased in all compression ratios, due to higher oxygen content.

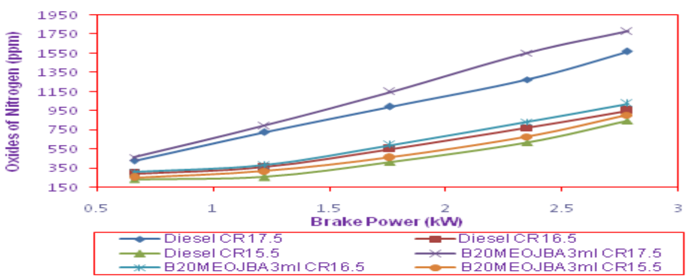

Figure 5: Oxides of Nitrogen with Brake Power (B20MEOJBA-CR)

The hydrocarbon with brake power variation is shown in figure 6. The decrease in compression ratio levels affects the HC emission increase for both diesel and B20MEOJBA3ml. In compression ratio B20MEOJBA3ml blends having closer HC emission compare with diesel. This was due to O_2 content in B20MEOJBA3ml balancing for O_2 insufficiency. In maximum load HC emission is measured as 27 ppm for diesel and 29 ppm for B20MEOJBA3ml in higher compression ratio.

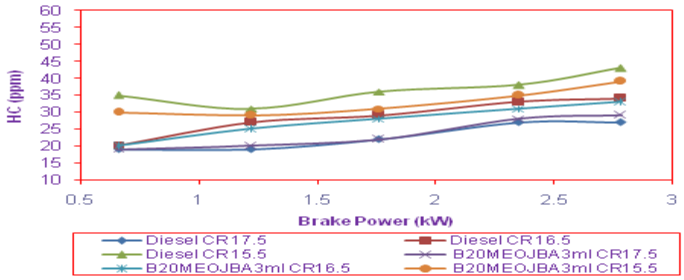

Figure 6: Hydro Carbon with Brake Power (B20MEOJBA-CR)

The variation in CO levels for various compression ratio of diesel and B20MEOJBA3ml operation at different conditions of load is depicted in figure 7. CO level is measured by % of volume as 0.13 for diesel and 0.07 for B20MEOJBA3ml at maximum load and higher compression ratio. In lean combination situation engine emits a reduced quantity of amount of CO. In the case of lower compression ratio CO emission % by volume is 0.16 for diesel and 0.15 for B20MEOJBA3ml at maximum load. The higher CO emission with lower compression ratio is due to oxygen scarce process.

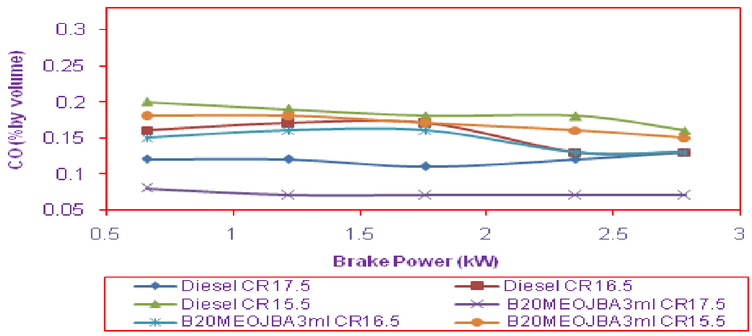

Figure 7: Carbon Monoxide with Brake Power (B20MEOJBA-CR

Combustion Characteristics

The cylinder pressure variation with crank angle is demonstrated in figure 8. Cylinder pressure measured in various compression ratio under full load conditions was found to be as good as diesel and MEOJBA. The cylinder pressure is noted in diesel for 72.55 bars and B20MEOJBA3ml for 73.55 bars at higher compression ratio condition. This is due to good mixture formation for compression ratio at maximum load where temperatures are far higher. The cylinder pressure at full load values with lower compression ratio of 16.5 and 15.5 were 62.31and 61.98 bars respectively for diesel whereas it was 64.09 and 62.730 bars for B20MEOJBA3ml. The main reason is lower compression ratio leads poor mixture, which reduces the cylinder charge temperature in the combustion chamber during the combustion process.

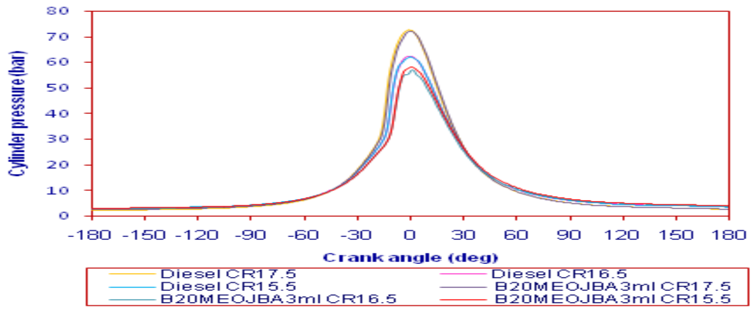

Figure 8: Cylinder Pressure with Crank Angle (B20MEOJBA-CR)

The variation between heat release rate and brake power is illustrated in figure 9. At full load condition, the heat release rate was 57.75 J/deg for diesel and 58.37 J/deg for B20MEOJBA3ml. There is a reduction in peak heat release rate for lower compression ratio operation. Decrease in heat release rate is a representation of incomplete combustion.

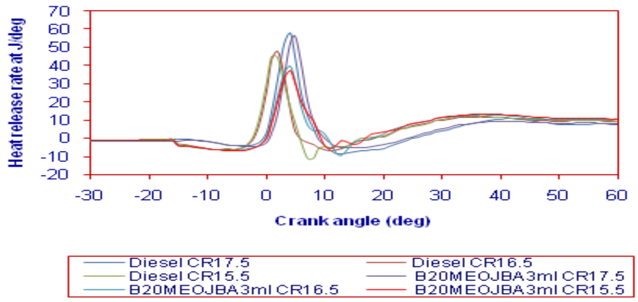

Figure 9: Heat Release Rate with Crank Angle (B20MEOJBA-CR)

CONCLUSIONS

The Specific Fuel Consumption with compression ratio of 17.5 at maximum load condition is measured 0.3 kg/kW-hr and 0.3 kg/kW-hr for diesel and B20MEOJBA3ml respectively. The Brake Thermal Efficiency with compression ratio of 17.5 similar trends is noted in both diesel and B20MEOJBA3ml. At maximum load, BTE of 28.18% is found in diesel under the compression ratio 17.5 whereas it was 28.12% using B20MEOJBA3ml compression ratio 17.5. the amount of smoke value of diesel is 81.2 HSU and B20MEOJBA3ml blend is 57.1 HSU at compression ratio 17.5. For both diesel and B20MEOJBA3ml blend NOx level was increased in all compression ratios. In maximum load HC emission is measured as 27 ppm for diesel and 29 ppm for B20MEOJBA3ml in higher compression ratio. CO level is measured by % of volume as 0.13 for diesel and 0.07 for B20MEOJBA3ml at maximum load and higher compression ratio. Cylinder pressure measured in various compression ratio under full load conditions was found to be as good as diesel and MEOJBA. The cylinder pressure is noted in diesel for 72.55 bars and B20MEOJBA3ml for 73.55 bars at higher compression ratio condition. There is a reduction in peak heat release rate for lower compression ratio operation. The best compression ratio is found to be 17.5 from the experimental analysis.

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